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# *Protaphycus shuvalikovi* Simutnik gen. et sp. nov. (Chalcidoidea, Encyrtidae, Encyrtinae) from Rovno amber

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## Abstract

*Protaphycus shuvalikovi* Simutnik **gen. et sp. nov.**, the smallest fossil Encyrtidae, is described and illustrated based on female specimen from late Eocene Rovno amber. Like most previously described Eocene Encyrtidae, the new taxon differs from the majority of extant encyrtids by the subapical position of the cerci, the relatively long marginal vein of the forewing, a distinctly swollen but not triangular parastigma, and a seta marking the apex of the postmarginal vein is not any longer than others on this vein. The new genus is characterized by the presence of a filum spinosum and the hypopygium reaching way past the apex of syntergum. This combination of the character states is known only in a few representatives of extant Encyrtinae. The new genus, probably, most closely related to the extant genus *Aphycus* Mayr, 1876.

## Keywords

cerci, Diptera, Eocene, filum spinosum, hypopygium, syninclusions

## Introduction

The data on fossil Encyrtidae were summarized in Simutnik et al. 2014, 2021a, 2021b, 2022; Simutnik and Perkovsky 2018; Simutnik 2021. The earlier described Paleogene Encyrtidae demonstrate remarkable morphological differences from extant ones. A

new fossil with a filum spinosum (the presence of which is one of the main features of the subfamily Encyrtinae) and the cerci only slightly advanced from the gastral apex is described below. Unlike most extant representatives of the subfamily, its hypopygium is not transverse, triangular and reaching way past apex of the syntergum.

## Material and methods

The studied specimen is housed in the collection of the Schmalhausen Institute of Zoology of the National Academy of Sciences of Ukraine, Kiev (**SIZK**). The amber piece containing the holotype (weight after primary treatment equals 40 grams) was found in the Zhovkini, Varash District, Rovno Region. At least eight *Sciara* zone Diptera (Perkovsky et al. 2012) were present in the piece as syninclusions (see below).

Zhovkini is one of the new localities from Varash District, that yielded dozens new taxa (Colombo et al. 2021; Golub et al. 2021; Simutnik et al. 2021b; Vitali and Perkovsky 2022; Yamamoto et al. 2022); Zhovkini inclusions comprise new cicadellids (Dietrich, pers. com.) as well as first Rovno ptylodactylid and other interesting beetles (our data; Telnov, pers. com.).

The specimen was examined and photographed using the equipment and techniques described in Simutnik et al. (2022). Photographs were taken using Leica Z16 APO stereomicroscope equipped with a Leica DFC 450 camera and processed with LAS Core and Adobe Photoshop software (brightness and contrast only).

Terminology and abbreviations follow Sharkov (1985), Gibson (1997), and Heraty et al. (2013). For the identification and description the specimen, we also used the keys by Trjapitzin (1989), Guerrieri and Noyes (2000), and Noyes (2004). The following abbreviations are used in the text: **F1, F2, etc.** = funicular segments 1, 2, etc.; **LOL** = minimum distance between the anterior ocellus and a posterior ocellus; **OOL** = minimum distance between an eye margin and the adjacent posterior ocellus; **OCL** = minimum distance between a posterior ocellus and the occipital margin; **POL** = minimum distance between the posterior ocelli.

## Results

### Systematic paleontology

**Chalcidoidea Latreille, 1817**
**Encyrtidae Walker, 1837**
**Encyrtinae Walker, 1837**

**Genus *Protaphycus* Simutnik, gen. nov.**
https://zoobank.org/A53F90E1-9ADE-4AA1-8C65-F80165FE0233

**Type species.** *Protaphycus shuvalikovi* Simutnik, sp. nov.

**Species composition.** Type species only.

**Etymology.** The new genus, probably, most closely related to the extant genus *Aphycus*. The genus name is a masculine noun.

**Diagnosis. Female.** It is the smallest of the described fossil members of the family, 0.6 mm length. Habitus 'encyrtiform', body compact, squat, not flattened; frontovertex subquadrate; notaular lines present anteriorly; F1–F3 almost ring-like; forewings 2× as long as broad, linea calva also unusually wide, entire; filum spinosum and covering setae (sensu Sharkov 1985) present; bare strip resembling a speculum runs alongside linea calva, basal to row of covering setae, below parastigma; parastigma distinctly swollen; marginal vein relatively long, longer than postmarginal, and about as long as stigmal vein; uncus well-developed; cerci located close to gastral apex; apex of hypopygium reaching way past apex of last gastral tergum (Fig. 2C: hyp, syn); ovipositor sheaths small, only slightly exserted, separated from hypopygium (Fig. 2C: v3).

**Remarks.** Placement of *Protaphycus* in Encyrtinae is supported by the presence of the filum spinosum of linea calva. The new genus somewhat resembles the extant genus *Aphycus* Mayr, 1876 in having a similar structure of the antenna: the clava is large, the pedicel is long, the funicular segments are transverse; the mesoscutum has incomplete notaular lines; the linea calva is entire, with distinct covering setae; the parastigma is distinctly swollen. But it is distinguished by the long marginal vein; the linea calva is noticeably wider; the presence of bare area alongside linea calva, basal to row of the covering setae; the seta marking the apex of the postmarginal vein is no longer than others on the marginal and postmarginal veins; the relatively short mesobasitarsus; and by the subapical position of the cerci.

Unlike most extant representatives of the subfamily, the hypopygium in *Protaphycus* is not transverse, triangular and reaching way past apex of the syntergum (Fig. 2C: hyp). Similar structure of the hypopygium is known in *Aphycus*, *Ageniaspis* Dahlbom, 1857, some species of *Copidosoma* Ratzeburg, 1844 and, possible, in a few other extant Encyrtinae. But, the apex of the hypopygium in these genera really extend only the apex of this syntergum and does not extend past of it. This state is only found in one or two other unrelated genera, e.g. *Coccidoctonus* Crawford, 1912 (J. S. Noyes, pers. comm. 2022).

From the *Aphycoides* Mercet, 1921 it differs by the presence of the distinct notaular lines, F1 shorter than its length, and a very wide linea calva.

From the *Oriencyrtus* Sugonjaev & Trjapitzin, 1974 which has some characters in common with *Protaphycus* and is definitely one of the most basal extant encyrtid genera (Noyes and Hayat 1994; J. S. Noyes, pers. comm. 2022) it differs by the presence of the filum spinosum. In addition, the forewings of *Protaphycus* are 2× as long as broad, this is unusually broad for encyrtids according to J. S. Noyes, pers. comm. 2022, and noted e.g. in the extant genus *Oesol* Noyes & Woolley, 1994 (Noyes and Woolley 1994; P: 1333).

***Protaphycus shuvalikovi* Simutnik, sp. nov.**

https://zoobank.org/39ACC8AE-D2E1-42C4-A8AB-092043010DA1

Figs 1, 2

**Material.** ***Holotype***, SIZK ZH-98, 1♀, Zhovkini, Varash District, Rovno Region, Ukraine; Rovno amber, late Eocene. The inclusion is in a yellow and clear piece of

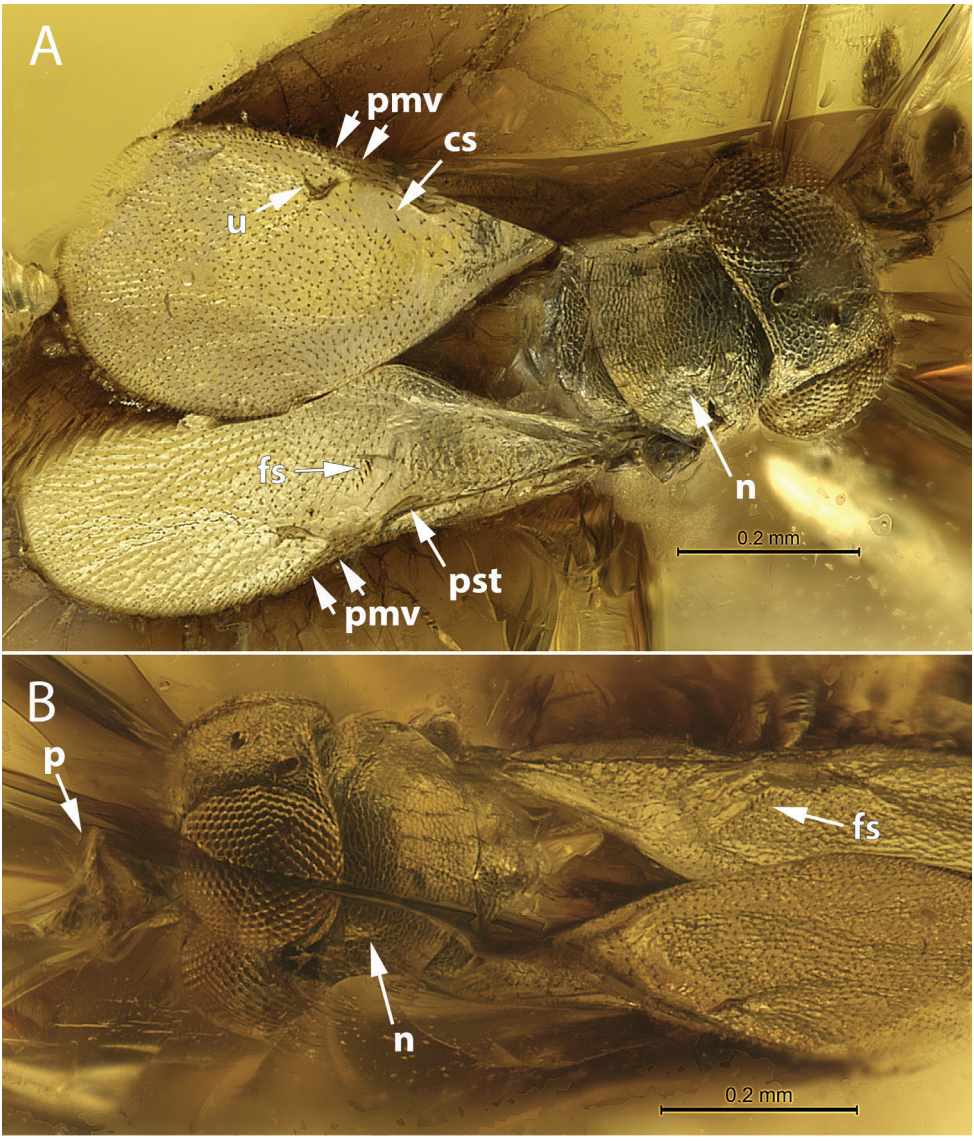


**Figure 1.** *Protaphycus shuvalikovi* gen. et sp. nov., holotype female **A** body, dorsal, (cs – covering setae; fs –filum spinosum; n – notaular line; pmv – postmarginal vein; pst – parastigma; u – uncus) **B** body, dorsolateral, (p – pedicel). Scale bars: 0.2 mm.

amber in a shape of irregular triangular prism (ca. 22 × 10 × 12 × 6 mm). All body parts are preserved.

**Syninclusions.** ZH-93 Coleoptera: ?Anthicidae; ZH-94 Diptera: Chironomidae; ZH-95 Coleoptera: Scirtidae; ZH-96 Coleoptera, 2 Diptera: Sciaridae, Cecydomyiidae); ZH-97 Diptera: Chironomidae; ZH-98 4 Diptera: Sciaridae, Limoniidae, Chironomidae, Nematocera; ZH-99 Hymenoptera: Mymarommatidae, Diptera: Chironomidae, Collembola: Entomobryomorpha; ZH-100 2 Diptera: Psychodidae,

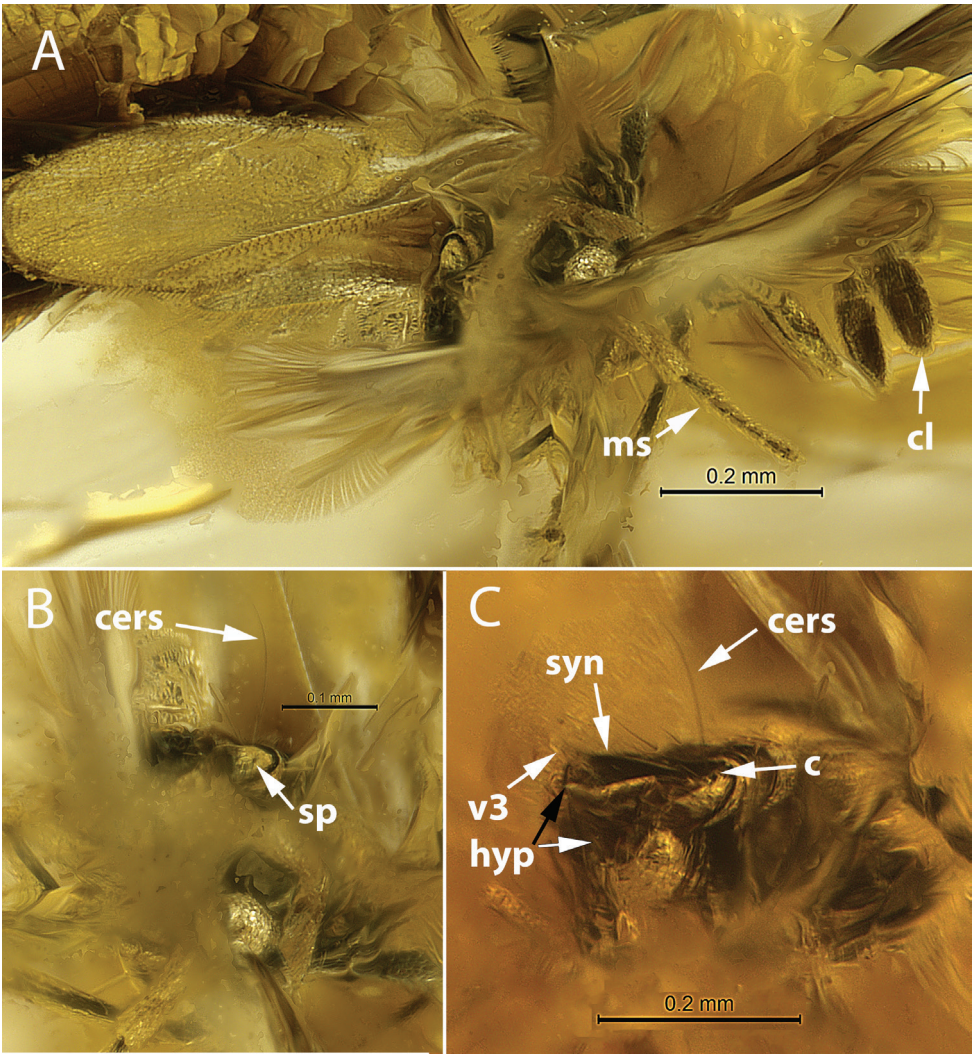


**Figure 2.** *Protaphycus shuvalikovi* gen. et sp. nov., holotype female **A** body, posteroventral (cl – clava, ms – mesotibial spur) **B** body, posteroventral (cers – cercal setae, sp – spiracle on the lateral plate of the Mt8) **C** gaster, posteroventrolateral (c – cercus, hyp – hypopygium - black arrow indicates the apex of the hypopygium ventraly, syn – syntergum, v3 – ovipositor sheaths). Scale bars: 0.2 mm (**A, C**); 0.1 mm (**B**).

Chironomidae; ZH-101 Hymenoptera; ZH-102 Limoniidae; ZH-103 Diptera: Sciaridae; ZH-104 Diptera: Sciaridae; ZH-105 Diptera: Empididae; ZH-106 Diptera: Chironomidae; ZH-107 Thysanoptera; ZH-108 Diptera: Chironomidae; ZH-109 Diptera: Brachycera; ZH-110 Diptera: Chironomidae; ZH-111 Thysanoptera: Thripidae; ZH-112 2 Diptera: Hybotidae, Chironomidae.

**Etymology.** The species is named in memory of our colleague Vladimir Borisovich Shuvalikov, an entomologist, geneticist, and teacher.

**Description. Female.** Habitus as in Fig. 1A, B. Body length 0.6 mm.

***Coloration and sculpture.*** Body, tegula, legs, gaster dorsally and ventrally black; clava darker than F6 (Fig. 2A); surface of frontovertex, mesoscutum, scutellum and axillae smooth, shiny (probably due to the presence of a thin layer of air), but without visible metallic shine; mesoscutum with rare black setae (Fig. 1A), ovipositor sheaths pale yellow; head, thorax, legs, and gaster shallow reticulate, but surface of head only sparsely punctate, some cells of frontovertex with one convex point (Fig. 1A).

***Head.*** Hypognathous, slightly wider than thorax in dorsal view, about 1.5× as broad as long; occipital margin sharp, but not carinate (Fig. 1B); eyes clothed in sparse setae 2× as long as diameter of eye facet (Fig. 1A), with inner orbits parallel; frontovertex only slightly longer than broad, almost one-third head width; ocelli in right-angled triangle, posterior ocelli elliptical in dorsal view, OOL about one-third posterior ocellus diameter (Fig. 1A, B); OCL slightly shorter than posterior ocellar diameter; OOL:POL:LOL:OCL about 1:8:5:2; eye reaching occipital margin; facial cavity, location of toruli, and interantennal prominence not visible in holotype.

***Antenna.*** Geniculate, 11-segmented (1:1:6:3); scape long, not widened (Fig. 1B); pedicel conical, about as long as F1–F4 combined, longer than any segment of funicle, all funicular segments transverse, F1–F4 very small and subequal (Fig. 1A, B), mps not visible; F6 twice as broad as long (Fig. 2A); width of flagellomeres increases toward apex; at least, all segments of clava with mps (Fig. 2A); clava large, only slightly shorter than funicle (Fig. 1A); about 2× as long as broad, with small oblique truncation (sensor region) on rounded apical segment (Fig. 2 A), wider than F6; flagellum and clava clothed in very short setae.

***Mesosoma.*** Pronotum almost vertical, with small transverse dorsal surface (Fig. 1A, B); mesoscutum broader than long, flat, notaular lines present as grooves (Fig. 1A, B: n) at extreme anterior part of mesoscutum; axillae transverse-triangular with anteromedial angles contiguous (Fig. 1A); scutellum flat, about as long as mesoscutum.

***Wings.*** Fully developed, forewings wide, with round apex; linea calva with filum spinosum, covering setae along basal margin of linea calva present, well developed (Fig. 1A,B: cs); area basal to covering setae bare and looking like speculum (Fig. 1A); hyaline break (unpigmented area) present; proportions of forewing venation, shape of parastigma, and setation of linea calva as in Figs 1A,B, 2A; marginal vein 2× as long as broad and about 1.5 as long as postmarginal (Fig. 1A,B); stigmal vein with long narrow uncus, consisting row of uncal sensilla; seta marking apex of postmarginal vein of fore wing not longer than others on the marginal and postmarginal veins; setae of marginal fringe short.

***Legs.*** Normal in size, alike polygonal reticulate; tarsi 5-segmented, mesotibial spur slightly longer than mesobasitarsus, both relatively short (Fig. 2A).

***Gaster.*** Polygonal reticulate equal dorsally and ventrally; apex of hypopygium sharp, distinctly reaching way past apex of syntergum (Fig. 2C: hyp, syn); gonostyli (Fig. 2C: v3) separated from apex of hypopygium; lateral margin of hypopygium bare, without row of setae; shape of hypopygium, location of cercal plates, and cercal setae as in Fig. 2B, C.

**Male.** Unknown.

The earliest known Encyrtidae include one female and four males were ascribed to five different genera from middle Eocene Sakhalinian amber (Simutnik 2021; Simutnik et al. 2021a). They did not have the filum spinosum and differed significantly from the both extant and late Eocene European encyrtids. To date, 16 species from 14 extinct genera are described from the Rovno, Baltic, and Danish ambers. Half of them, including the *Protaphycus shuvalikovi*, had the filum spinosum and, putatively, belong to Encyrtinae. The most of the known European amber Encyrtidae differ from the majority of extant ones by the subapical position of the cerci, the relatively long marginal vein of the forewing, a distinctly swollen but not triangular parastigma, a short radicle, and by a seta marking the apex of the postmarginal vein that is not any longer than others on this vein. The *Sulia glaesaria* Simutnik, 2015 with a unique abdominal structure, a largest of the known extinct members of the family, was described from Danish amber and then reported from Rovno amber (Simutnik 2015a; Simutnik et al. 2021b).

A comparative morphological analysis of the paleontological data allowed tracing character changes in some morphological structures in members of the family from the middle Eocene, through the late Eocene, to the present (Simutnik 2021). However, further analysis is required to determine the place of these fossil on the phylogenetic tree.

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